SUPPORT POST SYSTEM FOR MOLTEN METAL PUMP

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FIELD OF THE INVENTION

[001] The invention relates to a clamp that may be used with a molten metal pump to secure a support post to a superstructure of the pump, and a support post that may be used with the clamp.

BACKGROUND OF THE INVENTION

[002] As used herein, the term "molten metal" means any metal or combination of metals in liquid form, such as aluminum, copper, iron, zinc and alloys thereof. The term "gas" means any gas or combination of gases, including argon, nitrogen, chlorine, fluorine, freon, and helium, which are released into molten metal.

[003] Known pumps for pumping molten metal (also called "molten-metal pumps") include a pump base (also called a housing or casing), one or more inlets to allow molten metal to enter a pump chamber (an inlet is usually an opening in the pump base that communicates with the pump chamber), a pump chamber, which is an open area formed within the pump base, and a discharge, which is a channel or conduit communicating with the pump chamber (in an axial pump the pump chamber and discharge may be the same structure or different areas of the same structure) leading from the pump chamber to the molten metal bath in which the pump base is submerged. A rotor, also called an impeller, is mounted in the pump chamber and is connected to a drive shaft. The drive shaft is typically a motor shaft coupled to a rotor shaft, wherein the motor shaft has two ends, one end being connected to a motor and the other end being coupled to the rotor shaft. The rotor shaft also has two ends, wherein one end is

coupled to the motor shaft and the other end is connected to the rotor. Often, the rotor shaft is comprised of graphite, the motor shaft is comprised of steel, and these two shafts are coupled by a coupling, which is usually comprised of steel.

[004] As the motor turns the drive shaft, the drive shaft turns the rotor and the rotor pushes molten metal out of the pump chamber, through the discharge, which may be an axial or tangential discharge, and into the molten metal bath. Most molten metal pumps are gravity fed, wherein gravity forces molten metal through the inlet and into the pump chamber as the rotor pushes molten metal out of the pump chamber.

[005] Molten metal pump casings and rotors usually employ a bearing system comprising ceramic rings wherein there are one or more rings on the rotor that align with rings in the pump chamber (such as rings at the inlet (which is usually the top of the pump chamber and bottom of the pump chamber) when the rotor is placed in the pump chamber. The purpose of the bearing system is to reduce damage to the soft, graphite components, particularly the rotor and pump chamber wall, during pump operation. A known bearing system is described in U.S. Patent No. 5,203,681 to Cooper, the disclosure of which is incorporated herein by reference. As discussed in U.S. Patent Nos. 5,591,243 and 6,093,000, each to Cooper, the disclosures of which are incorporated herein by reference, bearing rings can cause various operational and shipping problems and U.S. Patent No. 6,093,000 discloses rigid coupling designs and a monolithic rotor to help alleviate this problem. Further, U.S. Patent No. 2,948,524 to Sweeney et al., U.S. Patent No. 4,169,584 to Mangalick, U.S. Patent No. 5,203,681 to Cooper and U.S. Patent No. 6,123,523 to Cooper (the disclosures of the afore-mentioned patents to Cooper, insofar as such disclosures are not inconsistent with the teachings of this application, are

incorporated herein by reference) all disclose molten metal pumps. Furthermore, copending U.S. Patent Application No. __________ to Cooper, filed on February 4, 2004 and entitled "Pump With Rotating Inlet" discloses, among other things, a pump having an inlet and rotor structure (or other displacement structure) that rotate together as the pump operates in order to alleviate jamming. The disclosure of this copending application, insofar as such disclosures are not inconsistent with the teachings of this application, is incorporated herein by reference.

[006] The materials forming the components that contact the molten metal bath should remain relatively stable in the bath. Structural refractory materials, such as graphite or ceramics, that are resistant to disintegration by corrosive attack from the molten metal may be used. As used herein "ceramics" or "ceramic" refers to any oxidized metal (including silicon) or carbon-based material, excluding graphite, capable of being used in the environment of a molten metal bath. "Graphite" means any type of graphite, whether or not chemically treated. Graphite is particularly suitable for being formed into pump components because it is (a) soft and relatively easy to machine, (b) not as brittle as ceramics and less prone to breakage, and (c) less expensive than ceramics.

[007] Three basic types of pumps for pumping molten metal, such as molten aluminum, are utilized: circulation pumps, transfer pumps and gas-release pumps. Circulation pumps are used to circulate the molten metal within a bath, thereby generally equalizing the temperature of the molten metal. Most often, circulation pumps are used in a reverbatory furnace having an external well. The well is usually an extension of a charging well where scrap metal is charged (i.e., added).

[008] Transfer pumps are generally used to transfer molten metal from the external well of a reverbatory furnace to a different location such as a ladle or another furnace. Examples of transfer pumps are disclosed in U.S. Patent No. 6,345,964 B1 to Cooper, the disclosure of which, insofar as such disclosures are not inconsistent with the teachings of this application, is incorporated herein by reference, and U.S. Patent No. 5,203,681.

[009] Gas-release pumps, such as gas-injection pumps, circulate molten metal while releasing a gas into the molten metal. In the purification of molten metals, particularly aluminum, it is frequently desired to remove dissolved gases such as hydrogen, or dissolved metals, such as magnesium, from the molten metal. As is known by those skilled in the art, the removing of dissolved gas is known as "degassing" while the removal of magnesium is known as "demagging." Gas-release pumps may be used for either of these purposes or for any other application for which it is desirable to introduce gas into molten metal. Gas-release pumps generally include a gas-transfer conduit having a first end that is connected to a gas source and a second submerged in the molten metal bath. Gas is introduced into the first end and is released from the second end into the molten metal. The gas may be released downstream of the pump chamber into either the pump discharge or a metal-transfer conduit extending from the discharge, or into a stream of molten metal exiting either the discharge or the metal-transfer conduit. Alternatively, gas may be released into the pump chamber or upstream of the pump chamber at a position where it enters the pump chamber. A system for releasing gas into a pump chamber is disclosed in U.S. Patent No. 6,123,523 to Cooper. Another gas-release pump is disclosed in a co-pending U.S. Patent Application filed on

February 4, 2004 and entitled "Gas-Release System for Molten Metal Pump" to Paul V. Cooper, the disclosure of which that is not inconsistent with the teachings of this application is incorporated herein by reference.

[0010] A problem with known pumps is that that they include a superstructure that is positioned above the molten metal bath when the pump is in use. The pump motor, among other things, rests upon the superstructure. The superstructure is positioned above the molten metal bath by one or more support posts connected to the pump base. The support posts must, therefore, be attached to the superstructure to support it, and if more than one support post is used, each must maintain the superstructure at about the same height relative the pump base in order to keep the superstructure level. Each support post is attached to the superstructure by a post clamp that typically has a portion (such as a flange) that connects to the superstructure and another portion that connects to the support post.

[0011] The primary methods of locating and connecting each support post to the superstructure at the same relative height have been to machine a groove or hole in each post at the same location. If a groove is formed, it is formed in the outer surface of the support post, and the groove mates with a corresponding lip on a support post clamp. The clamp also includes a lower flange that connects to the superstructure and the flange and the lip support the weight of the superstructure. Such a system is shown in U.S. Patent No. 5,203,681.

[0012] Another known method for locating a support post relative a superstructure is by the use of a through-bolt hole. Utilizing this system, a hole, or bore, is drilled through each support post at the same location on each post. A cylindrical,

preferably two-piece post clamp having an aperture formed on either side, receives an end of the support post and a bolt is passed through the apertures and a bore (also called a through bolt hole) in the support post. Lower flanges on the post clamp are connected to the superstructure and the bore in the support post supports the weight of the superstructure. Such a system is shown in U.S. Patent No. 5,203,681.

[0013] A problem with these known methods of connecting a support post to a superstructure is the time required to precisely locate and machine the grooves or through bolt holes at the same location on each support post so that the superstructure is level when the pump is used. Another problem is that the weight of the superstructure is supported by grooves or bores in the support posts, which are usually made of relatively soft graphite. Supporting the weight of the superstructure in this manner can cause the support posts to crack or break.

SUMMARY OF THE INVENTION

[0014] The present invention solves these and other problems by providing a support post clamp that supports the weight of a pump superstructure on the top of the support posts. The clamp includes (a) a bottom flange for connecting to the pump superstructure, (b) a cavity for receiving an end of a support post, wherein the end has a top surface, and (c) a top flange for being positioned above the top surface.

[0015] The clamp is preferably a two-piece clamp wherein each piece has a bottom flange for attaching to the superstructure and an upper flange for being positioned above the top surface of a support post. When the clamp is mounted to the superstructure, a cavity is formed between the two pieces. The cavity is dimensioned to receive an end of a support post. When in use, the top end of a support post is received

in the cavity, and the superstructure is supported by the top surface of the end of the support post. It is preferred that a plurality of support posts (most preferably three) be used, in which case the superstructure is supported in part by each top surface of each support post. Because the height of the support posts, rather than the position of a groove or through bolt hole, determines the height of the superstructure relative the pump base, if more than one support post is used, they must be of substantially the same height.

BRIEF DESCRIPTION OF THE DRAWING

[0016] Figure 1 is a perspective view of a pump for pumping molten metal, which includes a plurality of post clamps and support posts according to the invention.

[0017] Figure 1A is a partial side view of a support post that can be used with the invention.

[0018] Figure 1B is a top view of a post clamp according to the inventor.

[0019] Figure 2 is a perspective view of a post clamp according to the invention.

[0020] Figure 3 is a side view of the post clamp of Figures 1 and 2, wherein the post clamp is mounted on a molten metal pump.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0021] Referring now to the drawing where the purpose is to illustrate and describe different embodiments of the invention, and not to limit same, Figure 1 shows a molten metal pump. During operation, Pump 20 is usually positioned in a molten metal bath B in a pump well, which is normally part of the open well of a reverbatory furnace.

[0022] The components of pump 20 that are exposed to the molten metal are preferably formed of structural refractory materials, which are resistant to degradation in the molten metal. Carbonaceous refractory materials, such as carbon of a dense or structural type, including graphite, graphitized carbon, clay-bonded graphite, carbon-bonded graphite, or the like have all been found to be most suitable because of cost and ease of machining. Such components may be made by mixing ground graphite with a fine clay binder, forming the non-coated component and baking, and may be glazed or unglazed. In addition, components made of carbonaceous refractory materials may be treated with one or more chemicals to make the components more resistant to oxidation. Oxidation and erosion treatments for graphite parts are practiced commercially, and graphite so treated can be obtained from sources known to those skilled in the art.

[0023] Pump 20 can be any structure or device for pumping or otherwise conveying molten metal, such as one of the pumps disclosed in United States Patent No. 5,203,681 to Cooper, copending U.S. Patent Application to Cooper entitled "Pump with Rotating Inlet" or copending U.S. Patent Application to Cooper entitled "System for Releasing Gas Into Molten Metal." The invention could also use an axial pump having an axial, rather than tangential, discharge. Preferred pump 20 has a pump base 24 for being submersed in a molten metal bath. Pump base 24 preferably includes a generally nonvolute pump chamber 26, such as a cylindrical pump chamber or what has been called a "cut" volute, although pump base 24 may have any shape pump chamber suitable of being used, including a volute-shaped chamber. Chamber 26 may be constructed to have only one opening, either in its top or bottom, if a tangential discharge is used, since only one opening is required to introduce molten metal into pump chamber

26. Generally, pump chamber 24 has two coaxial openings of the same diameter and usually one is blocked by a flow blocking plate mounted on the bottom of, or formed as part of, a device or rotor 100. (In the context of this application, "rotor" refers to any rotor that may be used to displace molten metal, and includes a device having a rotating inlet structure).

[0024] A motor 40, which can be any structure, system or device suitable for driving pump 20, but is preferably an electric or pneumatic motor, is positioned on superstructure 36 and is connected to an end of a drive shaft 42. A drive shaft 42 can be any structure suitable for rotating an impeller, and preferably comprises a motor shaft (not shown) coupled to a rotor shaft. The motor shaft has a first end and a second end, wherein the first end of the motor shaft connects to motor 40 and the second end of the motor shaft connects to the coupling. Rotor shaft 44 has a first end and a second end, wherein the first end is connected to the coupling and the second end is connected to device 100 or to an impeller according to the invention.

[0025] The preferred rotor is device 100 as disclosed in co-pending application entitled "Pump with Rotating Inlet," invented by Paul V. Cooper, the disclosure of which was previously incorporated herein by reference. A preferred coupling, rotor shaft and connection between the rotor shaft and device 100 are disclosed in a co-pending application entitled "Molten Metal Pump Components," invented by Paul V. Cooper and filed on February 4, 2004, the disclosure of which is incorporated herein by reference. Various pump components that may be used with a pump according to the invention are disclosed in copending U.S. Application No. _________, filed on February 4, 2004 and entitled "Molten Metal Pump Components," invented by Paul V. Cooper.

[0026] One or more support posts 34 extend form base 24 to a superstructure 34 of pump 20 thus supporting superstructure 36. In the preferred embodiment, post clamps 35 secure posts 36 to superstructure 34. A support post 34 is of any structure, shape and size suitable for use in a molten metal environment and for supporting superstructure 36, but each support post 34 is preferably cylindrical, comprised of graphite and has about a 4" diameter. Each support post 34 has a first end 34A that connects to pump base 24 and a second end 34B (as shown in Fig. 1A) that extends through superstructure 36 and interfaces with post clamp 35. Second end 34B has a top 34C, which is preferably flat. Because the height of superstructure 36 will be determined by the height of the support posts, if a plurality of support posts is used, each support post 34 is substantially the same height, meaning each is machined to a given height plus or minus about 0.010".

[0027] Each support post 34 has an outer surface 34D (which is preferably annular) and preferably has no grooves machined on outer surface 34D at end 34B, since grooves will likely not be used to support any of the weight of the superstructure. Preferably, a through-bolt hole 34E is machined in end 34B in order to provide compressive force to the two pieces of clamp 35, as described below. However, through-bolt 34E hole is optional. Further, because through-bolt hole 34E does not determine the height of superstructure 36, the diameter of hole 34E can be larger than the diameter of the through-bolt 37 used. Preferably, the diameter of through-bolt hole 34E is at least about 1/32" larger than the diameter of through bolt 37. This makes installation of a post clamp 35, should it include a through bolt hole, easier since bolt 37 can easily be inserted through hole 34E.

[0028] Post clamp 35 is preferably a two-piece clamp, made of steel, having substantially identical halves 35A and 35B, so only one half shall be described in detail. Half 35A has a lower flange 70 that includes an aperture for receiving bolt 37. Flange 70 is for connecting clamp half 35A to superstructure 34 and can be any structure or device suitable for this purpose. Half 35A includes a semi-cylindrical wall 74 having an aperture 76 and an upper flange 78. Preferably, section 74 is welded to flanges 70 and 78 although it can be connected to the flanges in any manner.

[0029] In use, a support post 34 is positioned through a hole (not shown) in superstructure 36 so that end 34B extends above superstructure 36. Halves 35A and 35B are positioned, respectively, on opposite sides of end 36B. Bolt 37 is passed through aperture 76 in wall 74 of half 35A, through bolt hole 34E and through aperture 76 in half 35B. A nut is applied to the bolt and as the nut is tightened it draws together the halves 35A and 35B together around end 34B so that end 34B is contained within the cavity formed by semi-cylindrical walls 74. Bolts are passed through each aperture 72 to secure the post clamp 35 to superstructure 34. When mounted as described, flanges 78 are positioned above top 34C of end 34B and support at least part of the weight of superstructure 36. However, any structure suitable for enabling at least part of the weight of superstructure 36 to be supported by the tops of one or more support posts may be used instead of flanges.

[0030] Having thus described different embodiments of the invention, other variations and embodiments that do not depart from the spirit of the invention will become apparent to those skilled in the art. The scope of the present invention is thus not limited to any particular embodiment, but is instead set forth in the appended claims

and the legal equivalents thereof. Unless expressly stated in the written description or claims, the steps of any method recited in the claims may be performed in any order capable of yielding the desired product.